Hardware Realization of an FPGA Processor - Operating System Call Offload and Experiences

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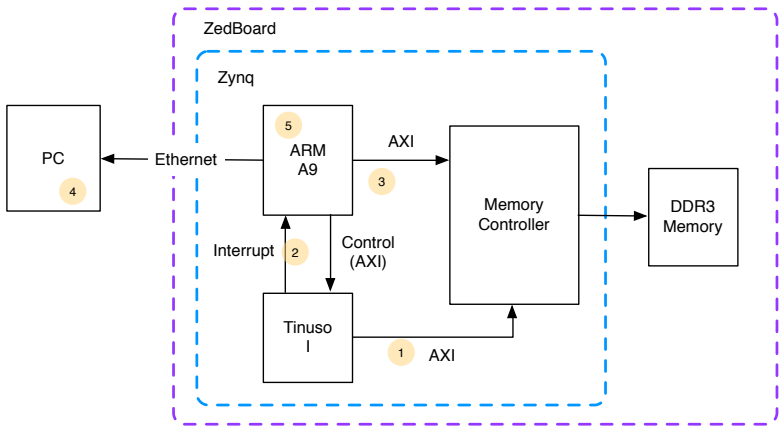
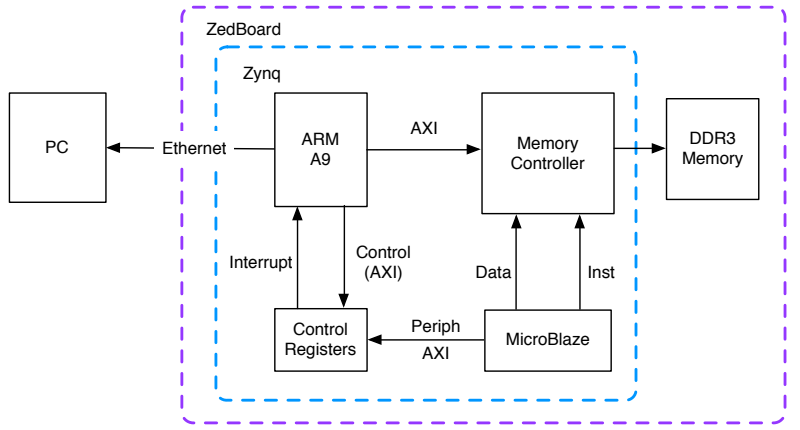


Tinuso-I system



Baseline MicroBlaze system

Motivation

- Benchmark programs such as those found in SPEC and SPLASH require access to operating system services such as the file system in order to run.
- These services are often unavailable on embedded platforms, because it is unfeasible to run a full operating system om these platforms.
- It is desirable to provide access to these services in order to be able to benchmark the platform with standard benchmarks.
- Porting a full operating system is usually not feasible.

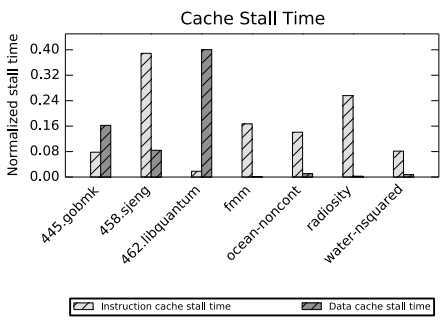
Contributions

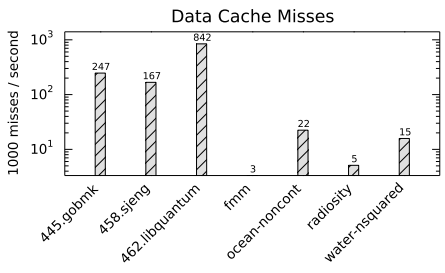
- We propose and implement a method for offloading operating system services and demonstrate the method with a Tinuso-I based system and a MicroBlaze system.
- We demonstrate the proposed method by using it to evaluate the Tinuso-I soft core processor using industry standard benchmark applications.

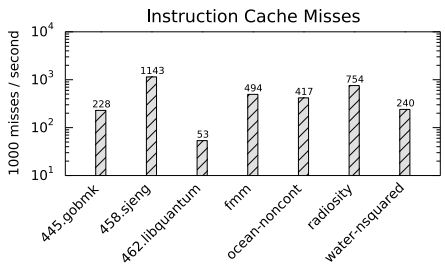
Implementation

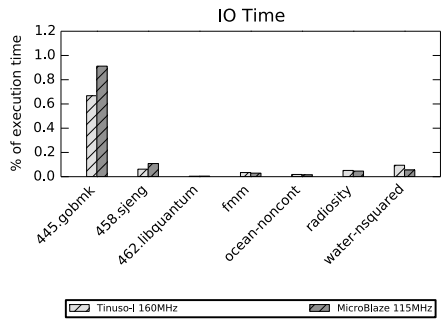
- Several software layers and components are needed to execute real applications. Applications are commonly developed assuming a POSIX compliant operating system. However, running a full operating system on small embedded systems is often unfeasible.
- We intercept file system service requests by linking the benchmark applications with a custom run-time library. When an application requests a file system service, such as invoking the open system call, the run-time library sends the request to a PC via a communication link. The response is received by the run-time and relayed back to the requesting program.
- With this approach it is possible to provide file system access to a processor core by only implementing the following: a) A minimal run-time library that intercepts file system service requests from programs running on the Tinuso-I core in FPGA fabric. b) Communication link support on the PC that services the file system requests and on the soft core. c) A service on the PC that responds to the file system service requests.
- We implement the proposed offloading method for a Tinuso-I core synthesised to the FPGA fabric of a Xilinx XC7Z020-CLG484-1 device. The silicon device is part of an AvNet ZedBoard development kit.

Results









Conclusion

- We use the Xilinx Zynq SoC to realise the Tinuso-I core and perform a hardware bring-up.
- We propose a method for offloading operating system service using the ARM core in the Xilinx Zynq SoC.
- We demonstrate our method by using it to evaluate both Tinuso-I and Xilinx Microblaze.
- We evaluate the system by executing a set of SPEC 2006 and SPLASH-2 benchmarks.
- We demonstrate a speedup of up to 64% over a similar Xilinx MicroBlaze baseline system.
- On average Tinuso-I performs 6% better than MicroBlaze while consuming 27% fewer LUTs.